Impacts to tourism and loss of cultural heritage from climate change and adaptation recommendations

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*Despite the high relief of this isolated volcanic island, Easter Island (or indigenous name of land and people – Rapanui[1]) is susceptible to the impacts of climate change through higher frequency storm surges with increasing coastal inundation and beach shoreline recession (Quilliam et al. 2014). The iconic cultural heritage[2] monuments (*moai*) play a determining role in securing tourist income, and in turn local economic injection. These* moai *and other ancient features are at great risk of damage with a great number located on the coastline and cliff faces. Other key risks for the island include water security and consequent food security. A strong role for local tourism operators is proposed as part of coordinated action with other similar places in Oceania and the rest of the island world.*

*A pesar del alto relieve de esta isla volcánica, llamada Isla de Pascua (denominada Rapanui [1] en lengua nativa, tanto para el lugar como su para su gente), es susceptible al impacto del cambio climático debido a la alta frecuencia de mareas de tormenta, con un incremento en la inundación costera y en el retroceso de la línea de playa (Quilliam et al. 2014). Los emblemáticos monumentos de patrimonio cultural [2] (*moai*) juegan un rol determinante en la obtención de ingresos turísticos y en la inyección de éstos en la economía local. Estos* moai *y otras antiguas figuras están en riesgo de ser dañadas, especialmente las que se encuentran en la línea de costa y acantilados. Otros riesgos importantes en la isla incluyen la seguridad del agua y subsecuentemente la de la alimentación. Se propone que los operadores del turismo local tengan un rol importante, como parte de una acción coordinada con otros sitios similares en Oceanía y el resto de las islas del planeta.*

Introduction

On the United Nations Environmental Program website,[3] Rapanui is given an "Isolation Index" number of 149, the maximum possible. The current indigenous population is probably around 3,500 persons; as the most recent (2012) census in Chile has been admitted to contain many errors, an estimate is the best information available. Estimates of the number of visitors annually to Rapanui vary, but there is a consensus around the figure of 100,000 annually, with the numbers growing as air services to the place improve.[4]

The point of mentioning the tourism figures is that our work below is concerned with water: the rising water in Oceania and the effect this will have on the fresh water aquifer. It is the fresh water that is affected by tourism, as even in the case of cruise ship tourism, visitors make high demands on local groundwater supplies of the places to which they travel.

The remoteness of this island combined with factors such as fish stock depletion and historic deforestation has meant that much of the local economy relies on income generated from tourism. Utilizing AR4 and AR5 (Intergovernmental Panel on Climate Change 2007) as the latest reports, it is estimated that in many small island nations such as Easter Island the harbor and low lying infrastructure will be at serious risk of regular tidal (coastal) inundation and sea level rise by 2100. The IPCC4 report predicts a significant decline in precipitation. This will threaten water security on Easter Island which already faces existing sustainability pressures such as food security, limited effective and safe water sanitation, poor waste management, and public health issues (Campbell 2008). Quilliam (2011) notes that issues such as water supply security, coastal inundation, beach erosion and recession due to high surge events (such as 100 year ARI storm events), including sea level rise, makes coastal climate change impacts more immediate for Easter Island with cliff instability, reliance on fisheries, and the integrity of harbor infrastructure at high risk.

Chile has had plans for the construction of a port almost since it annexed Rapanui on 9 September 1888. The most recent move in this direction was in 2009 when the Chilean firm, GHD, carried out a study for building a port where none exists at present.[5]

Institutional and financial constraints, along with limited adaptive capacity, have contributed to

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the challenges faced by Pacific Island governments and communities to address climate change issues (UNEP 2010). Climate change adaptation strategies for Easter Island need to focus importantly on the key issues of water and food security, preservation of cultural heritage sites on the southern coastline, and maintaining sustainable development to adequately support the per-manent population of Easter Island, but also improve current facilities to cope with large numbers of visitors who make significant contributions to the local economy.

History and its Importance to Understanding Climate Change

Easter Island has a rich Polynesian cultural history, with many scientists studying the unique and complex cultural and environmental records over past decades to understand the current socio-environmental conditions and how climate change will continue to have an impact on Easter Island's environment and its people (Quilliam et al. 2014). Much speculation still exists in scientific and anthropological research as to the impact that climate change has historically had on the population (societal) and environmental demise at its peak on the island in the 1600s, with some hypothesizing that climate change influenced the societal collapse on Rapanui (McCall 1979; Nunn 2000). It is generally recognized, however, through the limited studies to date (such as analyzing lake sediment cores), that the palaeoenvironmental history of Easter island remains poorly known and its geographic isolation makes it difficult to test climate change as a contributor to previous societal collapse (Mann et al. 2003; Stenseth & Voje 2009). Stenseth & Voje (2009:113) note that:

> "combining the insight presented by other researchers such as Cobb et al. (2003), Cianelli et al. (2005), Murphy et al. (2007), Durant et al. (2007) and Piatt et al. (2007), it seems reasonable to hypothesize that much of the marine resources surrounding Easter Island may have been profoundly affected by severe changes in climate (which in turn might have affected marine resources traditionally hunted by the islanders) during the periods of great societal and cultural changes".

These findings and the research to prove hypotheses for past climate change impacts on Easter Island are important to the current understanding and formulation of climate adaptation strategies.[6] Research into future climate change effects and what adaptation strategies to prioritize is critical to the long term viability of Easter Island's tourism sector, as is the necessity to determine sustainable level of population.

Climate Change Impacts – Tourism Cause and Effect

Easter Island is located in the center of the South Pacific Gyre, a basin-wide anti-clockwise turning current circulation. Large scale climate drivers that affect Easter Island include: El Niño, La Niña, Southern Annular Mode, and the Decadal and Inter-decadal Pacific Oscillation (Quilliam et al. 2014). Although the island is not exposed to tropical cyclones, the southern coastline exhibits the highest energy ground swells propagated from storms in the southern ocean. The north coast is relatively sheltered by comparison.

The effect of this over millennia is that the south coastline has a deep soil cover and is the location of good agricultural ground, whilst along the northern, more protected, part of the island, cover is sparse. In terms of sea level rise and its consequences, though, the south coast is more low lying and thus, sea level rise and consequent aquifer penetration will strongly affect local crop production. The high cliffs of the northern coast offer protection from sea level rise, but are hardly inhabited and there is no agricultural production located in those areas. Most obviously, sea level rise will affect the (visited) sandy beaches at ʻAnakena, Ovahe, and Hangaroa, used by visitors and residents alike for recreation.

Concern exists for the cultural heritage monuments located on the south coast. The Rapanui culture manifested itself between the eleventh and seventeenth centuries in great works such as the *ahu* – ceremonial platforms – and carved *moai* – colossal statues, that represented ancestors (McCall 1994). Figure 1 provides a map of Easter Island showing the main township of Hangaroa and exposed coastline of Akahanga, where a number of *moai* and *ahu* are situated. Quilliam (2011) notes that the *ahu* at Hangaroa and Tahai are at most risk of waves overtopping them at the current prediction of a 0.8m sea level rise. Minor wave overtopping is expected at an ARI of 10 years and 2 years respectively for 2100. Tongariki has a possible risk of wave runup likely to reach halfway up the seaward *ahu* wall by 2100.

It is worth noting that Tongariki, with its 15 *moai*, the largest *ahu* on the island along the south coast, was destroyed in 1960 by a tsunami as it is so low lying.

Reliance on agricultural activities includes the cultivation of sweet potato and chicken husbandry with limited coastal fishing. These agricultural based activities have declined in favor of the island shifting to a cash economy based on tourism. The opening of an airport at Mataveri near Hangaroa has permitted an increasing influx of tourists since the 1960s, as mentioned above, with a number of tourist accommodations and services becoming increasingly

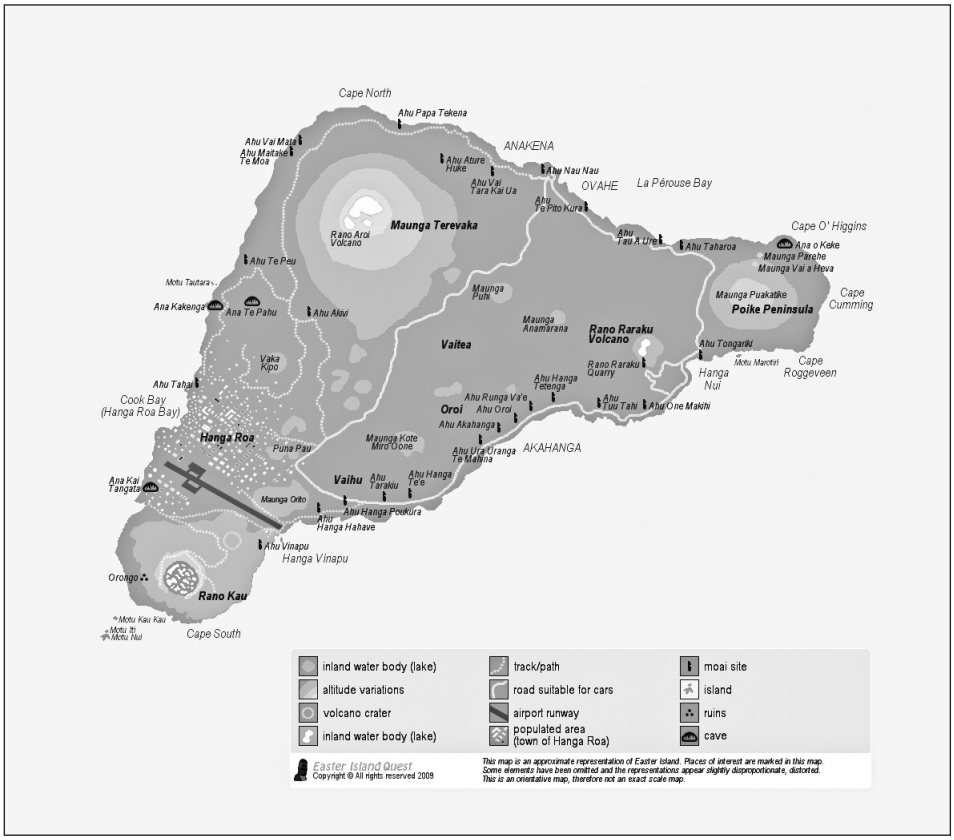

Figure 1: Map of Easter Island (Source: http://www.turismoisladepascua.com/mapas-isla-de-pascua/#)

important to the local economy. As a Chilean province, the Chilean government has developed an extensive institutional infrastructure on the island and there are daily flights from Santiago to Easter Island during the summer season.

A unique feature of economic life on Rapanui is that almost all the tourism operations on Rapanui are owned by the islanders themselves. This includes accommodation and transport as well as other supporting businesses found in the major town of Hangaroa. The exception is the illegally acquired "Hangaroa Eco Village & Spa" owned by the Chilean entrepreneurial Schiess family. The hotel sits on land illegally alienated from the indigenous Hito family in the 1970s, when the Pinochet dictatorial regime sold off State assets including the formerly government-owned "Hotel Hanga Roa". With this dishonorable exception, all other properties are substantially in the hands of the Rapanui.

Rapa Nui National Park is a protected Chilean wildlife area located on Easter Island covering approximately 7000 hectares (accounting for about 40% of the island's total area of 173.0 square km including four nearby islets,[7] which concentrates on the legacy of the Rapanui culture (UNESCO n.d.)). It was reported that 80% of the Easter Island economy comes from tourism with a staggering 65,000 visitors arriving every year (Legrand 2013). Legrand's figures are journalistic and, as indicated elsewhere, the volume of tourists is increasing every year. The foundation of the economy on Rapanui is tourism and all who live there rely on it. Legrand may be referring to those few Rapanui who find employment in the Chilean bureaucracy where most of the top posts are occupied, as they have been for over a century, by outsiders, principally Chileans. Some of the Rapanui indigenous population (approximately 30%) would like to see mass tourism that endangers the fragile ecosystem restricted or even eliminated. They often phrase this in terms of "higher quality" tourists, fewer in number who spend more per head. In the face of climate change, by potentially restricting the length of stay by tourists and directing more tourist revenue towards improving water treatment and harvesting, as well as improvement of sanitation and waste management, the threats of climate-induced change such as reduced precipitation may be better managed. Cliff instability, risk to harbor infrastructure, and loss of coastline heritage through more intense storm surges, and more frequent coastal inundation will require higher levels

of national and international assistance, although such help from non-Chilean sources is controlled from the metropole, Santiago.

A consistent demand from the islanders has been greater autonomy, allowing them to make decisions locally. Since Easter Islanders became full citizens of Chile and the heavy restrictions on both internal and external movement were removed in 1966 (after energetic local protests, see McCall 1997), the so-called "Easter Island Law" 16,441 provided the local population with benefits they had not had previously. In response to further protests and demands, including several government enquiries over several years involving several fully-paid visits of Chilean officials in "study tours", further autonomy was granted by Chilean Law 20,193 passed by the Chilean Congress on 30 July 2007.[8]

This law has yet to be implemented and Rapanui remains part of the 5th Region of Valparaíso, subject still to decisions from that place 3,680km distant. For many elements of management, the decision-making power lies with the national Chilean government, in even more distant (3,760km) Santiago de Chile.[9]

The previous paragraph might be taken as a critical political observation, however, it is the population of Rapanui who will experience the consequences of climate change, so they must necessarily be fully involved in the planning for adaptation process and implementation. Owing to the remoteness of Rapanui, local practical knowledge best leads to local practical solutions. Coping with predicted climate change and subsequent risk is less a technical matter than it is a social and managerial one. Undeniably, it therefore is an issue involved with local autonomy.

Whilst Chile does have a number of islands, the country primarily is a continental one and so is unlikely to share the concerns with a Polynesian population on a remote sub-tropical place like Rapanui. Local autonomy in decision-making would enable the Rapanui to consult with other oceanic island entities on climate change related issues. Unlike their Chilean counterparts, many Rapanui speak French and English, the languages of the rest of Oceania, this having come about due to the high numbers of visitors and the small number of locals who attend to them on cultural and academic exchanges.

Rapanui are very far from being "noble savages" in that romanticised view of native peoples who are absorbed by and care for their land, but they do have memories of how things were and are aware of how things are now. Perhaps this, too, is due to tourism: having to explain repeatedly over many years the features of one's own place. Rapanui are very close to being the ideal type for Yi-Fu Tuan's (1990) "topophilia", or love of place. People remember how their village used to have meandering streets before a Chilean-inspired grid was attempted to be imposed on the main settlement of Hangaroa. They also note how large fig trees used to line the main streets, offering shade: these were removed in the late 20th century by the Chilean authorities.

Adaptation Strategies for Water Security and Coastal Protection

Adaptation strategies are defined according to two key issues for population and tourism sustainability, with timeframes for adaptation strategies presented. The following adaptation strategies are summarized in Table 1 below. It is envisaged that short-term would include immediate strategies (within the next year), medium-term would include time periods between two to 10 years and long-term would be beyond 10 years.

For the *ahu* and *moai*, climate adaptation may be constrained to only a few feasible options, potentially protection through barriers in the short-term or accommodation in the short- to medium-term. Relocating the most vulnerable of the approximate 900 *moai* and *ahu* would be the last of the feasible options given the resources, approvals and cost involved in completing such as massive undertaking. Quilliam (2011) recommends physical modelling of the *ahu* and *moai* of Hanga Roa, Tahai, and Tongariki to determine the best climate adaptation strategies. Based on the preliminary modeling results conducted to date, strengthening of the seaward *ahu* walls for Hanga Roa and Tahai appears to be the best option considering all known factors.

We would add that islanders, particularly those active in tourism owing to their constant vigilance of such sites, should be engaged in the process of protection and preservation by involving Rapanui tourism operators and non-islander staff in environmental monitoring on the island. This would require resources to train locals in island appropriate environmental sciences and supporting a general and ongoing public awareness campaign. A similar approach should be targeted at the education system from primary school through to high school.

Securing the future preservation of the *moai* and *ahu*, as well as beach and coastal zones vulnerable to climate change impacts is important to the future management of tourism. This requires effective governance and political cooperation, as well as adequate funding to ensure these adaptation strategies occur in an effective manner. Mostly, though, it is the implementation of already gazetted Chilean laws permitting local autonomy mentioned above that are key to such a program of practical and locally-focused invigilation.

Table 1. Climate Change Adaptation Strategies – protection of water security and cultural heritage monuments.

Key issue	Adaptation strategies	Timeframe (short, medium or long term)
Water security	Upgrade current groundwater infrastructure to include new extraction wells, storage, pumping regimes, and leakage efficiencies.	Short to medium-term
	Fixing leakages in the existing infrastructure (current leakage of 35%) with better detection methods, and repairs	Short-term
	Increasing total potable water storage (groundwater supply infrastructure and rain water tanks)	Short-term
	Improving current water supply quality through better water treatment technologies	Short-term
	Desalination, recycled stormwater and wastewater plants	Short- to medium-term
Coastal zone protection	Protect – soft and hard engineered structures to be constructed to protect coastline from inundation	Medium-term
	Accommodate – Raising floor level of at risk structures and designing scour resistant foundations or floating structures	Short to medium-term
	Retreat – removing buildings and structures at risk to a further inland or protected location not at risk of inundation or storm surge.	Long-term
Agriculture and Fisheries	Investigation into feasibility of hydroponic cropping	Short to medium-term
	Investigation into feasibility of aquaculture given current decline in fishing resources and increased decline due to climate change induced impacts	Short to medium-term
Research	Quilliam (2011) recommends further research required into:	Short to medium-term
	1. Geological, Hydrogeological, Geophysical, and Hydrogeochemical investigations to determine the size, quality and sustainable yeilds for the groundwater resources on the island.	
	2. Aquaculture and Agronomic studies	
	3. Physical modelling of high risk coastal sites to determine the risk of damage to *ahu* and *moai*.	
	4. Geological and Geotechnical investigations regarding the Rano Kau sea cliffs	
	We would add:	
	5. Islander attitudes to features of their environment	
	6. Islander proposals for local solutions to their part in global problems	

The following high-level strategies provide a summary of the achievable adaptation measures to manage the impacts of climate change:

Governance:

- Work to continue with the government of Chile to support and assist with adaptation measures including further research, funding, and sharing of knowledge
- Education of resident population regarding land and animal management, waste management, and sanitation
- Implementation of an already approved Chilean law for local autonomy
- Engagement of the local population in the problems and issues, to devise their own views, solutions, and preferred timelines.

Tourism:

- Tourist numbers considered to be a sustainable number of tourists predicated by current limitations in water security, waste management, sanitation, and other environmental constraints
- Levy applied to every tourist that is directed to improving water security, sanitation, waste management, and water treatment. This is done already in the Galapagos Islands of Ecuador, which country's governing law is similar to that of Chile
- Portion of levy to contribute to coastal zone protection measures, including further research into accommodating *moai* and *ahu* at risk
- Tourist education campaign to improve waste management (i.e. key messages regarding waste reduction and recycling encouraging tourists to take plastic water bottles that can be recycled with them rather than disposing on island)
- Engagement of local tourism operators in carrying out surveillances of places of significance and risk, coupled with coping strategies.

Scientific Research:

- Continued effort to research and improve knowledge on likely climate change impact.
- Utilizing international engineering bodies and universities to incorporate more research assignments for Easter Island, investigating methodologies for coastline protection
- Improved cooperation with like authorities in other island jurisdictions, in Oceania and elsewhere.

Notes

1. "Rapanui" for the name of Easter Island is consistent with nomenclature in the rest of the Pacific Islands. It is the name that the Islanders give for themselves, their language and their island. "Rapa Nui" is the aberrant spelling used officially by the Chilean government for the name of the island when they do not write it in Spanish as "Isla de Pascua". Similarly, on official maps, Chileans often render Rapanui place names broken by hyphens, claiming that such words are "too long".
2. The "Rapa Nui National Park" was inscribed in the Unesco World Heritage List in 1995 with reference 715 and consisting of 6,666 ha. The geographical coordinates for this inscription are S27 8 60 W109 27 0 (http://whc.unesco.org/en/list/715). Some writers believe that the whole of the island was so inscribed and this is mistaken.
3. http://islands.unep.ch/IXE.htm#271.
4. The government "Easter Island Tourism Office" offers no such figures (http://www.descubreisladepascua.com, accessed on 1 September 2014). The Chilean National Office of tourism (SERNATUR) declares a 2012 figure of 86,949, "representing an increase of 17.3% over 2011". Following a similar increase, that would make an expected 2014 statistic of 118,979 visitors. Over the years many have observed that visitor numbers to Rapanui do not appear to be affected by economic factors. http://www.sernatur.cl/noticias/sernatur-lanza-plan-para-el-desarrollo-turistico-en-isla-de-pascua).
5. Please see the website (in Spanish) for the GHD Company (http://www.ghd.com/chile/projects/puertos-para-isla-de-pascua/).
6. Most recently, Mulrooney et al. (2009) and Mulrooney (2013) argue for a substantial revision of Rapanui's prehistory and development. The usual focus on islander culpability in the alteration of the island is questioned based upon the author's most recent research.
7. http://islands.unep.ch/IXE.htm#271.
8. http://islands.unep.ch/IXE.htm#271.
9. There are several websites providing this sort of calculation. We choose (http://www.timeanddate.com/worldclock/distances.html?n=914) as we have used it before and have verified its accuracy from other sources. There are other distance and relational calculations for Rapanui on the same page for the curious.

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